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DEGREE OF STUDENT CONTROL OVER PROGRAMED INSTRUCTION--LONG-TERM CUMULATIVE EFFECTS ON PROBLEM-SOLVING AND TRANSFER.

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DESCRIPTORS- *GEOGRAPHY, EDUCATIONAL RESEARCH, *PROGRAMED INSTRUCTION, ELEMENTARY SCHOOL STUDENTS, *ACHIEVEMENT TESTS, *ACHIEVEMENT GAINS, *PROBLEM SOLVING, GRADE 4, GRADE 5, PALO ALTO, CALIFORNIA, CALIFORNIA ACHIEVEMENT TEST (CAT)

THE PURPOSE OF THE STUDY WAS TO DETERMINE WHETHER GIVING THE LEARNER CONTROL MIGHT SHOW PROGRESSIVE EFFECTS ON LEARNING AND PROBLEM-SOLVING IN A GIVEN SUBJECT MATTER OVER A PERIOD OF SEVERAL MONTHS. ALL FOURTH-GRADE STUDENTS IN 3 ELEMENTARY SCHOOLS AND 2 FIFTH-GRADE CLASSES FROM 1 OF THESE SCHOOLS PROVIDED APPROXIMATELY 200 SUBJECTS. SCHOLASTIC ABILITY WAS A GRADE PLACEMENT SCORE OF 5.5 FOR THE FOURTH-GRADE STUDENTS ON THE CALIFORNIA ACHIEVEMENT TEST (CAT). ON THREE VARIABLES THE STUDENTS WERE MATCHED--(1) MEAN CAT TOTAL READING SCORE, (2) MEAN SCORE ON A SIMPLE GENERAL GEOGRAPHY PRETEST, AND (3) MEAN INTEREST IN GEOGRAPHY BY QUESTIONNAIRE. ONE CLASS WAS DESIGNATED LEARNER CONTROL AND THE OTHER PROGRAM CONTROL. THE TWO TEACHERS ALTERNATED CLASSES ON A WEEKLY BASIS. THE FOUR MATCHED PAIRS OF CLASSES CONSTITUTED FOUR REPLICATIONS OF THE RESEARCH DESIGN. AN 8-MONTH COURSE IN PRINCIPLES OF GLOBAL GEOGRAPHY WAS CHOSEN FOR ITS EMPHASIS ON TRANSFER OF PRINCIPLES AND PROBLEM SOLVING. A DRAFT PROGRAMED INSTRUCTIONAL TEXT WAS USED AND OBJECTIVE AND CRITERION TESTS FORMULATED. THERE WERE MARKED DIFFERENCES IN OVERALL LEVEL OF ACHIEVEMENT AMONG SCHOOLS IN THE PATTERN OF LEARNER CONTROL-PROGRAM CONTROL DIFFERENCES. THERE WAS A MARKED AND CONSISTENT DIFFERENCE BETWEEN LEARNER CONTROLLED AND PROGRAM CONTROLLED GROUPS IN THE FREQUENCY OF HOMEWORK. THE PROGRAM CONTROL GROUP TOOK WORK HOME ABOUT TWICE AS OFTEN DURING THE FIRST HALF OF THE COURSE, AND THE DIFFERENCE DIMINISHED DURING THE LAST HALF. THE CHANGE IN PERFORMANCE ON PRE- AND POST-TESTS OF THE COURSE UNITS WAS NOT SIGNIFICANTLY DIFFERENT. THE FINAL CRITERION TEST RESULTS SHOWED NO SIGNIFICANT DIFFERENCE. (HB)

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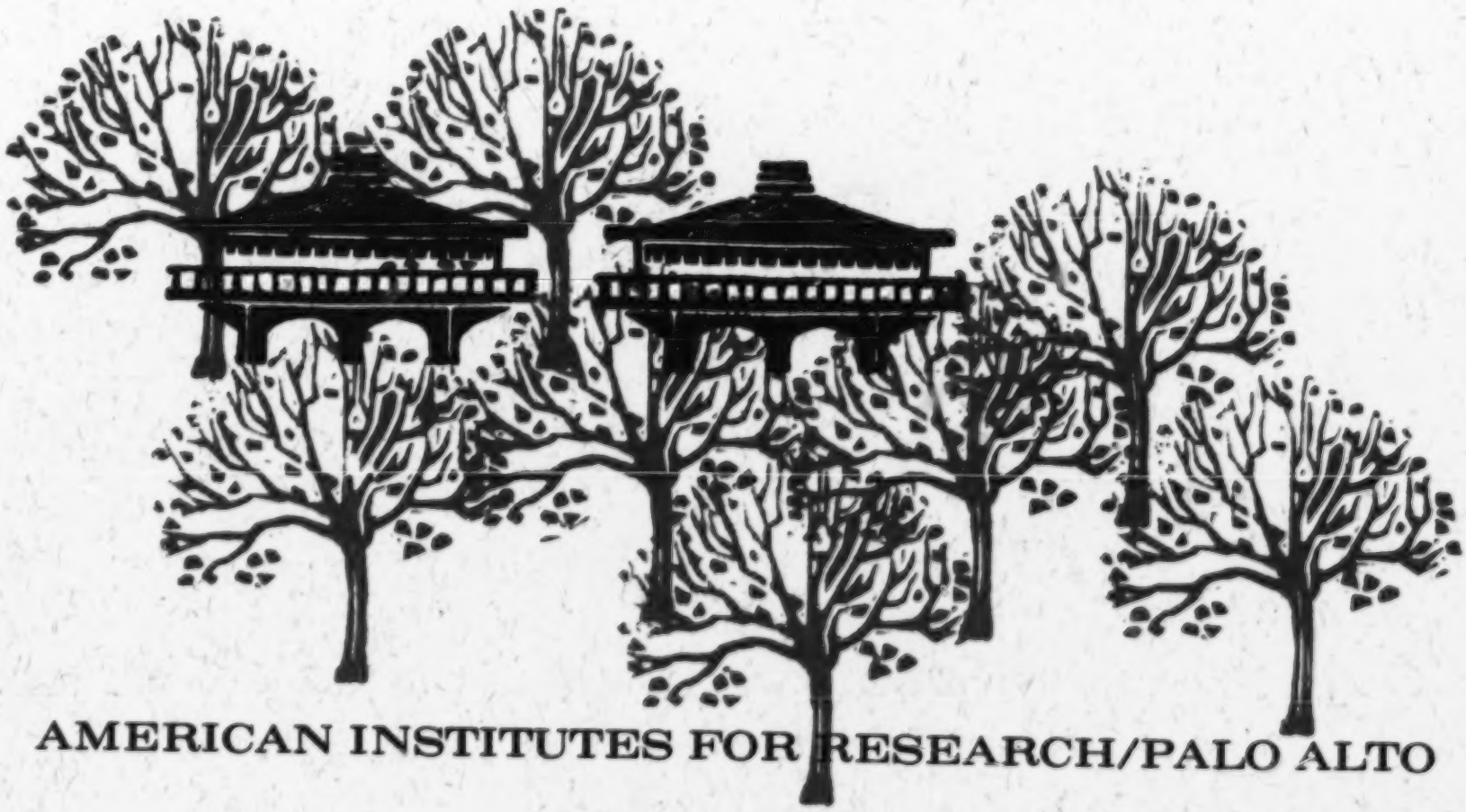

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ABSTRACT

Purpose. A series of pilot studies had suggested that programed instruction would be at least as effective if the learner were given much greater control over the instructional process than is usually given, and perhaps more effective for topics which require problem-solving and transfer. On this basis an eight-month elementary school course in principles of global geography was used to compare learner-controlled instruction with the most effective program-controlled instruction which we could devise.

Procedure. Specific objectives of the course were determined, and all tests and learning materials were oriented toward these objectives. The individualized learning materials included printed instruction, pictures, maps, filmstrips, experiments conducted by S, and practice problems similar to criterion test items. Four matched pairs of 4th- and 5th-grade classes (N = 216) took the experimental course under their regular teachers, who were given special training and assisted by the research staff. In one class of each pair study materials were arranged in an indexed file so that S could organize, evaluate, and direct his own learning. In the other class of each pair, the same total instructional resources were presented to each S as a programed sequence over which he had little control. A given pair of learner-controlled (LC) and program-controlled (PC) classes were taught by the same two teachers, who alternated between classrooms each week. Both methods allowed the teachers to assist individuals freely. About 25% of the geography class time in both LC and PC classes was spent in group activities such as movies, discussions, and games. There were no homework assignments but frequency of voluntary homework was recorded.

A questionnaire measuring interests and attitudes and a general geography test were given at the start of the course and again just before the last unit. For the last unit both LC and PC classes were given a less ready-made set of study resources in which each S had to locate relevant material under learner-controlled conditions.

On each of the nine units of the course a final criterion test was given on the last day of the unit to all Ss. Similar forms of the test were available for Ss to take individually earlier, and if they passed an early test they were free to engage in enrichment activities until the

final test. Enrichment thus served as an incentive to reach criterion performance as soon as possible. Five months after completion of the course a new one-hour test covering the whole course was given. Parts of the test differentiated the skills of remembering principles, applying principles, locating relevant principles, and combinations of these skills.

Results and conclusions. Mean scores on the unit final tests varied from 60% to 77% and were quite similar for the LC and PC groups, differing by less than 5% on every unit. The LC group means were initially slightly lower but gradually gained ($p < .01$) during the eight months, although the trend was hardly noticeable. Mean time required to reach criterion performance on each unit was not appreciably different for the two methods. The PC group voluntarily took work home about twice as frequently as the LC group during the first part of the course, but the difference diminished somewhat as the course progressed. On the final unstructured unit, the pre-post geography test and the five-month-delayed test, performance of the two groups was equivalent.

Pre-post changes in answers to the questionnaire indicated ($p < .05$) that the LC group gained in interest in geography while the PC group showed a slight loss in interest over the eight months. LC and PC groups both gained in preference for self direction of study, but the LC group gained more ($p < .05$).

We inferred that conditions common to the two learning treatments were probably more important than the variables which differentiated them. Implications of this for deciding what variables deserve future attention were discussed. The possibility was mentioned that higher interest in the topic might eventually augment learning by the LC method, especially if students are allowed to set their own goals, as well as means, for a larger part of the school curriculum.

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We would like to express our gratitude to the Menlo Park School District and the following personnel for their steadfast cooperation and intelligent participation in the experiment: Supt. Franklyn O. White, Director of Instruction William Howe and former Director William W. Fisher (now at Cupertino School District); principals -- Ennio Ciolli, Walter Key, Ina Porter, and James Biggerstaff; to the following teachers of the experimental classes we are additionally indebted for their skillfully playing the roles of teacher and experimenter at the same time: Agnes Abend, Marilyn Franklin, Janet Kerroll, Marjorie Lake, Lucille Markovich, Mary Noble, Jane Pennell, Judy Webley, and George Wildberger. Other teachers who gave valuable help in constructing course materials were Lillian Garner, Jean Lewellyn, Patricia Lipousky, and David Lotz. Prof. C. Langdon White of San Jose State College served ably as subject matter expert.

On our own staff Dr. Mary B. Willis was author of most of the test and practice problems; Jeannette Stephens and Donald Terry assisted in conducting the research.

Introduction

Educational research is starting to move educational practice toward more individualized instruction. Our research concerns who should control the ongoing process of individualized instruction, the student himself or experts such as teachers and programers? The experts usually know more about the learning task, the subject matter, and what conditions favor learning generally. But for reasons concerning meaningfulness, self evaluation and motivation, giving the learner control may sometimes be more sound.

It is an accepted fact that meaningfulness greatly affects rate of learning. But meaningfulness is not simply a property of stimuli. It is determined jointly by the stimulus and what is happening in the learner's head. An expert may be able to judge as well as the learner which stimuli will be more meaningful to people in general. But the learner seems in a better position to judge the meaningfulness of a particular experience because only he knows what he's experiencing; that is, meaningfulness of any single event is quite subjective. And for most learning tasks, failure to get meaning will cripple learning on down the line in that subject matter. Of course the learner may mistakenly overrate his own understanding as a result of getting the wrong meaning. Furthermore, good self evaluation is not likely to improve learning unless S knows appropriate alternative study tactics and chooses among them wisely on the basis of his evaluation.

Even more important, perhaps, is the fact that the learner is always there, physically present in the learning situation where he can continuously monitor his own progress. A private tutor can do this too, perhaps better, perhaps not. Mager's pioneering work on learner control (e.g., Mager & Clark, 1963) indicated that even with a tutor learning was faster if the learner was allowed to structure the learning task. Even supposing a tutor could control one student to advantage, a teacher in charge of 25 students can't get to any one very often. And a programer, or text book writer is in a far worse position for monitoring progress. A complex computerized branching program is there all the time in theory, but has not proven itself in practice yet.

Another critical factor in rate of learning is motivation. People often seem happier when they organize their own plans to pursue their own goals. Pre-school children in particular are eager and enthusiastic learners. Why does this eagerness seem to decrease steadily from year to year in school? It may be partly because students are controlled too closely. Having so little freedom and responsibility perhaps takes the fun out of school. At Summerhill School (Neill, 1960) students study only what they please when they please and with a high degree of freedom of expression. Neill claims that the efficiency of intrinsically motivated learning more than makes up for whatever time is spent idly.

In most early studies of self-directed learning and independent study, the learner control variable was not separated from the degree of individualization of instruction. Whitlock, Copeland, and Craig (1963) found that individual independent study and programed instruction were equally effective and both were superior to regular classroom instruction. In the few

other recent studies which held individualization constant, learner control was found to be at least as efficient as program or teacher control, and sometimes more efficient. Those studies are reviewed in an article summarizing our own pilot studies on learner control (Campbell, 1964). Our pilot studies, too, suggested that learner control was at least as effective as program control for a few hours of instruction, and perhaps more effective in topics which emphasize problem-solving and transfer.

The purpose of the present experiment was to see whether giving the learner control might show progressive effects on learning and problem-solving in a given subject matter over a period of several months, perhaps as a result of the student gradually acquiring new skills in evaluating and directing the learning process. The effects of main interest were periodic performance during the experimental course indicating conceptual learning and transfer in the subject matter, changes in interest in the subject matter, and attitudes toward self-directed learning.

Our general approach was to compare what seemed to be the most promising integrated instructional package emphasizing learner control with what seemed to be the most effective way of teaching the same thing using substantially greater program control. Each of the two methods was intended to represent a sensible combination of irstructional rules and procedures which would be feasible in nearly any school setting.

Method

Subjects and Design

All 4th-grade students in three elementary schools (two classes from each school) and two 5th-grade classes from one of these schools served as subjects (Ss). Eliminating those who entered or left the school district

during the year, there were a total of 216 Ss. Their scholastic ability was above average as indicated by the mean grade placement score of 5.5 for the 4th-grade Ss on the Reading subtest of the California Achievement Test. At each school the two classes at the same grade level were matched at the start of the year on three variables: mean CAT Total Reading score, mean score on a simple general geography pretest, and mean interest in geography as measured by a questionnaire. One class was arbitrarily designated the learner-control (LC) class for the whole experimental course, and the other the program-control (PC) class. The two teachers alternated classes weekly so that the effect of teacher differences on class performance would be minimized. The four matched pairs of classes constituted four replications of this basic design.

Materials and Procedure

An eight-month course in principles of global geography which was part of the regular curriculum for the district was chosen for the experiment because of its emphasis on transfer of principles and problem-solving. The course was divided into nine units varying from two to four weeks in length. The early units taught basic principles of water, air, earth and sun which were applied in later units dealing with life and climate in certain wind belts. The course was held for 45 minutes each day, either four or five days a week depending on the school.

Draft programed instructional booklets for the course had been developed during previous years (Fisher, 1963). With the help of regular teachers from the district, including the eight experimental teachers, and a professional geographer, detailed objectives for the course were specified and from the objectives we constructed criterion tests and learning

materials. There were three roughly parallel forms of the criterion test for each unit. The three forms were the same length and had about the same proportion of multiple-choice and open-ended items. The tests required about a half-hour to complete on the average. A majority of the items required problem-solving or transferring principles to new situations.

One of our pilot studies (Campbell, Bivens, & Terry, 1963) had indicated that motivation may play a stronger role in learner-controlled instruction than in program-controlled instruction. In order to compare the methods under at least moderately high motivation to learn, we offered all Ss in both LC and PC classes enrichment activities (filmstrips, games, illustrated books, etc.) as an incentive for learning enough to pass a criterion test. Most of the enrichment activities were related generally to the unit being studied, but were not oriented to the particular objectives. The passing score required to get enrichment on a given unit was not constant for all Ss. A fixed passing score would have provided little incentive for Ss who found it either very easy or practically impossible to achieve. Passing scores were set for each S to match approximately (within 10%) his achievement on the previous unit. The only other constraint was that the mean passing score required be equal for the LC and PC classes of a matched pair on any given unit. We set a lower limit on passing scores of 50% and an upper limit of 90%. Observation throughout the year gave the impression that the passing scores for enrichment nearly always provided a realistic incentive.

During the summer preceding the course a three-week tryout of draft learning materials for the first unit using eight paid Ss from a different

school district aided revision of instructional techniques and gave the experimental teachers an opportunity to practice novel procedures. The novelty for the teachers consisted not in their instructional acts per se -- helping individuals, orienting and organizing the class, keeping discipline, etc. -- but in keeping systematic records of new kinds of data and trying to prevent extraneous factors from differentially influencing LC and PC classes. Explicit printed guides and checklists were provided to the teachers for each unit of the course to facilitate handling of materials, record keeping and scientific controls.

The individual learning materials for every unit except the last consisted mainly of the following components mimeographed on 8 1/2" X 11" paper.

1. The objectives themselves were listed on one to four pages, not as performances but as principles which concisely stated what Ss needed to understand in order to be able to answer a wide variety of questions and problems. The objectives were listed in what seemed the most logical order to learn them, and lettered A, B, C . . . etc. Before each objective were listed the letters of prior objectives from the same or an earlier unit which would directly contribute to understanding that objective.

2. Practice problems required Ss to apply the basic principles (objectives) in a variety of contexts. Correct answer keys were provided to Ss, and they understood that these problems were similar to and representative of those in the unit criterion tests, but not the exact same problems.

3. Short programed segments explained in the simplest fashion we could imagine the basic concepts or relations of an objective, or of part of an objective. These programed segments called for frequent participation by S, usually in the form of written answers or choices among alternatives, but also including map work and actual experiments with water, air, soil, and heat. Fairly frequently a programed segment referred S to a filmstrip (and occasionally to certain pages in a reference book) which explained and illustrated a particular idea or phenomenon. Several individual filmstrip viewers and usually two copies of each filmstrip or book were available in each classroom. Some of the program responses tested S's understanding of an experiment or a filmstrip, but most referred to the verbal or pictorial content of the program itself. Correct answers appeared on the same page along the right-hand margin; S kept the answers covered with a strip of cardboard which he slid down to reveal individual answers after making his own response. Programed segments required on the average 10 or 15 minutes for completion, but varied considerably in length. At the end of most programed segments was a brief summary calling for 2 or 3 responses by S to indicate his understanding of the segment as a whole. No correct answers were provided in this summary, so that if S was not sure of his answer he was to review the segment.

The form in which the above materials were presented and the procedures for using them defined the difference between the LC and PC methods of instruction.

Learner-control (LC) classes. At the start of each unit each LC S was given a 10" X 12" cardboard expanding vertical file containing his mimeographed learning materials. The components described above were color coded.

In the back of the file were the lists of objectives for that unit and for previous hierarchically related units, a unit glossary, and a study guide which described the kinds of learning materials and tests available and suggested ideas for planning one's own study. The remaining slots in the file were lettered A to Z as were the objectives. Thus, for each objective there was a slot in the file which contained practice problems for that objective stapled in a single booklet, and the short programed segment(s) for that objective, which were called "workbooks." For the later units, some of the practice problems were assembled into larger "practice tests" which S could take anytime he wanted. In addition, general classroom references, maps and globes were available.

Each S was allowed to use his file of materials in any ways he pleased, and all LC Ss were encouraged to think for themselves, to critically evaluate their own progress, and to revise their study tactics accordingly. If one approach was not working, S was to try something different. Teachers answered whatever questions Ss asked and gave individual help in other ways. Teachers never suggested a definite study plan to an S except to the extent of reminding S of some of the different resources available. Even then such coaching was usually given by questioning S about his tactics and leading him to decide for himself what he would try next. For the first 10 minutes of each geography period LC Ss were asked to review their progress and plan how they would study that day. Six to eight randomly chosen Ss in each LC class were observed regularly (one period a week early in the year, less often later) and the number of times they referred to each different type of component was counted.

LC Ss were allowed to take the Form I criterion test whenever they felt ready. If they passed they were free to engage in enrichment activities until the class as a whole completed that unit, except during the first 10 minutes of each period when all Ss were required to review and/or plan. If they did not pass the Form I test, they had to correct their wrong answers using their study materials and were then free to study in whatever manner they chose until they felt ready to try another test (Form II). Passing Form II freed Ss for enrichment and failing it required Ss to correct the test and continue studying until the last day on the unit on which all Ss in both LC and PC classes took the Form III test. The LC and PC classes of a matched pair always started and finished a unit together.

Program-control (PC) classes. The same basic components of instruction (objectives, practice problems and programed segments) were presented to the PC Ss in a fixed program over which Ss had little control. All learning materials for one unit, except approximately half of the practice problems, were presented to S in the form of a linear programed book, the components appearing in the following order:

1. A review of the rules which S was to follow in studying the program
2. The objectives for the whole unit
3. A brief review of prior objectives directly related to Objective A of this unit
4. Objective A
5. The programed segment(s) for Objective A
6. A few practice problems (1 to 6) on Objective A

7. Numbers 3 to 6 above repeated for Objective B and each objective thereafter

8. The first few objectives of the unit repeated on a single page (Such groups of objectives were formed by dividing the unit into 2 to 4 parts at natural breaking points).

9. A group of practice problems covering this first group of objectives

10. Elements 8 and 9 above for each of the remaining groups of objectives

11. The objectives for the whole unit, preceded by the instruction, "Read the following summary once through carefully. After you finish it you will take a test."

The PC Ss were required to work straight through the program without skipping ahead, to answer all questions and follow all instructions in the program. With books one cannot be sure that all Ss do exactly as instructed, but teachers and staff observed very few departures from the required procedure. Form I of the unit criterion test was given to each PC S as soon as he finished the linear program. If he passed he was freed for enrichment activities except for the 10 minute review which began each period. If S failed he was made to correct his test, then restudy those segments of the program covering objectives on which he had missed test items, then work a group of new practice problems covering those same objectives. S then reviewed all objectives and took the Form II test. If he passed he was given enrichment; if he failed he followed the procedure just described for failing Form I, using a new set of practice problems.

Procedures common to both methods. The PC Ss shared a few rather important freedoms with the LC Ss because we felt it would be unrealistic to deny PC Ss these key choices which would almost certainly be allowed in any applied setting.

1. They could ask questions at any time.

2. They could proceed at whatever speed they chose.

3. They could review parts of the program completed.

4. They could take materials home any day. There were no homework assignments in either LC or PC classes, but Ss were always free to take work home. The names of Ss who took work home were recorded by the teacher each day.

A unit was terminated for the LC and PC classes of a pair when all Ss in the PC class had finished the basic linear program, or within a day or two thereafter. All Ss in both classes were given 20 minutes or more (depending on the size of the unit) to review just before taking the Form III test. On most units a few Ss took no criterion test other than Form III because they were not ready earlier (LC) or because they had not completed the program in time (PC). Usually less than half of either class took the Form II test. All Form III tests were scored by two staff members. Disagreement between scorers was rare but the frequency was not quantified.

The interest questionnaire and general geography pretest used for matching classes were given the first two days of the school year, and were readministered to all Ss again after the eighth unit. Both LC and PC classes were given short practice units just before the first geography unit. The practice units familiarized Ss with the LC or PC format. The

LC practice unit was presented in a file in the same way as the geography units would later be presented. Likewise the PC practice unit was in the form of a linear programed book. The objectives for the practice units became the study guides which appeared as part of the study materials for all geography units. Enrichment was given for passing a criterion test early.

The ninth and final geography unit (Trade Winds) was unlike the first eight units in that LC and PC classes were both given the same materials and rules of study. The Trade Winds unit provided a less ready-made learning situation for all Ss in that there were no short programed segments to study and fewer practice problems. All Ss were in a highly learner-controlled study situation. Each S had a list of the Trade Winds objectives and a few practice problems. Available to each class as a whole were copies of the objectives of previous related units, programed geography units from previous years which contained some relevant and some irrelevant material, atlases, globes, encyclopedias, and other general references. All Ss were told to use the available resources in whatever ways they wanted. However, they were advised to save some practice problems to test themselves with later rather than trying to work them all immediately, as many were starting to do since the booklet of practice problems was the only thing initially facing each S that looked like "something to study." The criterion testing and enrichment incentive was the same as for the LC classes on the first eight units except that there was no Form II test. Ss knew that passing Form I was their only chance to get enrichment. Form III was given to all Ss on the final day of the unit, as on previous units.

Throughout the geography course the individualized instruction described thus far consumed 70% to 80% of the time during geography periods. The other 20% to 30% was spent in group learning experiences such as class discussions, movies, or question games. The number of minutes spent on a given type of group event was recorded by the teachers and was kept equal for the two classes of a matched pair on any given unit. The group learning feature may possibly have diminished differential effects of the LC and PC methods, but one pilot study (Campbell & Bivens, 1963) had suggested that it would be a desirable source of variety which would help to maintain adequately high motivation through the year.

Delayed criterion test. One pair of 4th-grade classes met twice a day during the fall and thereby finished the course early in April. The 5th-grade classes which had taken a similar geography course the previous year (partly individualized, all program- or teacher-directed), finished early in May. The other two pairs of 4th-grade classes finished early in June. Approximately five months later, in late October, the experimental classes were given a four-part geography test which all Ss completed in less than an hour without being rushed. It covered the whole course but emphasized the last six units, in which principles were applied and integrated to a greater extent. All of the items were new to the Ss, but similar in form to items previously encountered. Part One (20 points) tested recall and recognition of the main principles of the course. Parts Two, Three, and Four involved problem-solving and transfer. Each problem in Part Two (10 points) was preceded by a statement of the principles needed to solve the problem. The problems in Part Three (7 points) all concerned the 7th unit (Doldrums) and each S was given a copy of the Doldrums

objectives but no other supplementary information. Thus, while Part Two was intended to assess ability to apply one or two relevant given principles to a problem, Part Three required the additional skill of locating and identifying the principles which were relevant to each problem. Part Four (13 points) consisted of problems for which no supporting information at all was given, so that Ss were required to both recall the relevant principles and apply them to a new problem.

Results

By all outward appearances both learning methods were used by Ss approximately as we intended and expected. LC Ss followed a wide variety of study strategies while PC Ss followed the prescribed rules. In every LC class, when we first turned Ss loose with their files of study materials there were a few minutes of bewildered disbelief, but they quickly adapted to the situation. The LC Ss who were observed periodically did not as a group show any marked systematic changes through the year in their frequency of use of the different study resources, at least not after the first week. This is not to say that individuals did not change their study plans in various ways, which many did.

Performance on the Sequence of Geography Units

The means and standard deviations on the Form III unit tests are shown in Table 1. There were marked differences in overall level of achievement among schools, generally corresponding to grade level and mean reading ability differences, but no apparent differences among schools in the pattern of LC-PC differences. Combining all schools, the performance on Form III tests was very similar for the LC and PC groups throughout the course. The difference between means for the two methods was less than 5%

Table 1

Means and Standard Deviations of LC and PC Classes

on the Form III (Final) Criterion Test for Each Unit of the Course

		Matched Pair of Classes[a]				All Pairs	
		A	B	C	D		
Unit	Method	Mean				M	SD
1	LC	62.0	73.5	65.0	71.3	67.6	13.6
	PC	68.3	73.0	67.0	73.9	70.5	13.2
2	LC	65.2	77.5	65.1	71.7	69.6	16.1
	PC	66.0	74.8	66.5	78.4	71.3	16.5
3	LC	69.8	78.4	64.3	75.9	71.8	14.1
	PC	75.6	80.1	71.9	79.5	76.7	13.9
4	LC	71.7	77.2	63.7	73.0	71.2	14.9
	PC	65.0	73.5	65.5	79.3	70.7	15.6
5	LC	71.5	75.6	58.0	78.6	70.5	18.3
	PC	64.0	75.2	67.5	80.0	71.6	17.8
6	LC	64.0	72.9	61.6	73.7	67.7	15.5
	PC	67.7	71.7	66.5	72.2	69.5	13.1
7	LC	66.6	72.3	58.7	75.5	67.8	15.7
	PC	65.8	74.5	60.0	77.7	69.4	14.0
8	LC	60.9	65.2	54.1	67.5	61.6	16.0
	PC	60.1	66.4	52.4	63.3	60.5	13.8
9[b]	LC	65.5	61.7	53.0	69.5	62.1	18.7
	PC	58.8	67.2	49.5	71.9	61.8	18.4

[a] Pair D is the 5th-grade classes. Pair C is the 4th grade from the same school.

[b] Unstructured unit

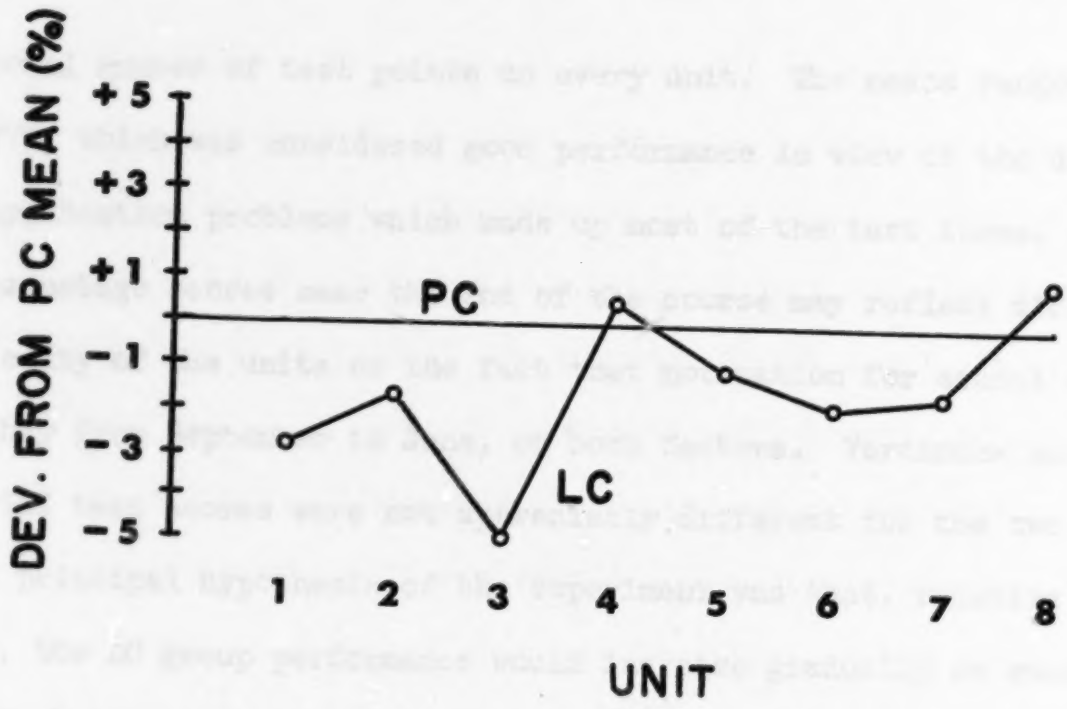

Fig. 1 LC group means on Form III unit test scores(%) expressed as deviations from PC group means.

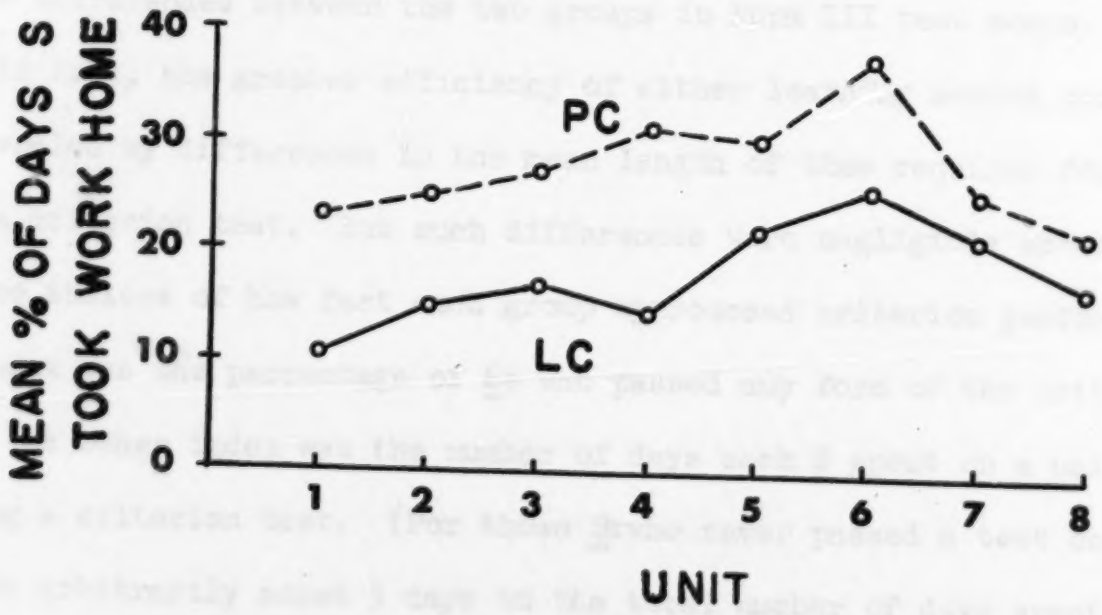

Fig. 2 Mean % of days on each unit on which work was taken home under LC and PC methods.

of the total number of test points on every unit. The means ranged from 60% to 77%, which was considered good performance in view of the difficulty of the application problems which made up most of the test items. The lower percentage scores near the end of the course may reflect differences in difficulty of the units or the fact that motivation for school drops appreciably from September to June, or both factors. Variances among Ss in Form III test scores were not appreciably different for the two methods.

The principal hypothesis of the experiment was that, relative to the PC group, the LC group performance would increase gradually on successive units. Such a trend can be seen, with some effort, in Figure 1, which shows the LC group means as deviations from a base line formed by the PC group means. The trend is statistically significant ($p < .01$, one-tailed, comparing the 1st and 8th units) but certainly nothing to get excited about.

It may be argued reasonably that by equating for the LC and PC groups the mean passing scores needed to get enrichment we experimentally prevented larger differences between the two groups in Form III test means. Even if this is true, the greater efficiency of either learning method should then be revealed by differences in the mean length of time required for Ss to pass a criterion test. But such differences were negligible according to our two indices of how fast each group approached criterion performance. One index was the percentage of Ss who passed any form of the criterion test; the other index was the number of days each S spent on a unit before passing a criterion test. (For those Ss who never passed a test on a given unit we arbitrarily added 5 days to the total number of days spent on the unit; e.g., if the class spent 13 days on the unit, an S who failed all the criterion tests he took was given a score of 18 days "to reach criterion.")

There was a marked and consistent difference ($p < .001$) between LC and PC groups in the frequency of voluntary homework. Figure 2 shows the difference in terms of the mean percentage of days on which an S took work home for the sequence of eight units. The PC Ss took work home about twice as often during the first half of the course, and the difference diminished during the last half of the course. If homework time could be added to study time, the LC group might appear to learn more efficiently by having achieved the same level of test performance after less studying. However, there was no measure of number of hours spent studying at home and no basis for determining how substantial an effect homework had on test performance.

The change in performance on the brief general geography test given just before and after the sequence of eight units was not significantly different for the LC and PC Ss. Both groups' mean scores increased from 52% to 76%. Considering that chance score was 32%, the gain represented 36% of the non-chance range of possible test scores.

Unstructured final unit. On the ninth unit, in which all Ss were given a high degree of control over their own study with relatively unprepared learning materials, broad skills of self-direction acquired by LC Ss during the first eight units should have been revealed. But the Form III test means were nearly identical for the LC and PC groups. If any self-directing skills were acquired by the LC Ss they may have been rather specific to the format in which the first eight units were cast. Examination of other criteria of performance on the ninth unit corroborated the test score results. The frequency of homework was nearly identical, and only 4% more LC Ss than PC Ss passed the Form I test, not a significant difference.

Delayed Criterion Test

Ninety per cent of the 216 Ss were still available for testing five months after completion of the course. The LC and PC groups were virtually equivalent in mean scores on each of the four delayed criterion subtests and in mean total test score (63%). The differences between LC and PC means were in all cases less than 1.5% of the total number of test points. Mean total test score for 4th-grade Ss (in 5th grade at time of delayed testing) was 61% for both the LC and PC groups, and 44% for the students in the same grade who were new to the district and presumably had not had a comparable course in geography the previous year. Considering that chance score on the total test was 30%, the experimental Ss achieved over twice as much on the delayed criterion test as control Ss who had not taken the geography course.

Changes in Motivation

Two measures were derived from the questionnaire given before and again near the end of the course: interest in learning about geography, and preference for directing one's own study rather than depending on the teacher to do it. On both of these variables the LC Ss gained significantly ($p < .05$) more between pre and post testing than did the PC Ss. The LC group showed a mean increase in interest in geography while the PC group showed a slight mean decrease in interest in geography. LC and PC groups both gained in preference for self-direction, but the LC group gained significantly more than the PC group.

All questionnaire items were statements to which S indicated his degree of agreement on the same five-point scale (strongly agree, agree, can't answer, disagree, strongly disagree). The six statements scored

to obtain the two motivational measures were embedded among 24 other statements concerning attitudes toward school. The statements used to assess interest in geography were: "Geography is fun to learn." "There are a lot more interesting subjects than geography." "Learning about things like the sun and earth is useful to me." The statements used to assess preference for learner control were: "I like my teachers to tell me exactly how they want me to learn." "I would rather have a teacher who always solves my problems for me." "I would probably do better in school if I weren't always being told what to do."

Discussion

The results present a coherent picture of the relative merits of learner and program control as practiced during one eight-month course. Test performance was nearly equivalent throughout the course and five months later, but interest in the subject matter was better nurtured by learner control.

Considering that the LC and PC methods were about equally effective on the achievement criteria, it may be that the conditions common to the two treatments were more important than the conditions which differentiated them. That is, for both groups the objectives were clearly identified and the hierarchical relations among them were explicitly shown. The elements of instruction were carefully prepared and linked with their proper objectives. Practice problems and program responses provided ample opportunity for all Ss to evaluate their own progress. If their progress did not satisfy them they could restudy completed materials or seek help from teachers and parents. These commonalities may have mattered more than who controlled the decisions as to how to use the various components of instruction.

It should also be noted that in the present experiment LC Ss had no choice in what they were to learn, only in how they would go about it. The specific objectives of the course were ours, not the students'. Choosing one's own goals may well be a key factor in augmenting learning through learner control.

The finding that giving learners more control gave them a taste for more control as well as a greater interest in the topic suggests that learner control might in the long run enhance learning by better maintaining motivation to learn. However, projecting into the future the gradual gain in test performance of the LC group relative to the PC group (Figure 1), it would be years before there was an important difference. Then, too, no longer-term gain would be expected if the LC group's gradual gain was caused by the diminishing difference between groups in frequency of voluntary homework (Figure 2). Changes in homework and in interest are both more plausible explanations of the gradual LC gain than is the growth of self-direction skills, in view of the findings of equivalent performance on the unstructured final unit in which both LC and PC groups were highly self-directed. Perhaps acquisition of broadly useful skills such as planning, organizing and searching which generalize to many new situations requires more individual coaching than was available to our Ss; and perhaps it requires a more variable set of learning resources and conditions such as might be provided by learner control of the whole curriculum for many years rather than by a single course which has uniform conditions of control.

The main implication of the present research may be an economic one. If students directing their own learning can achieve at the same academic

level as students following the best program we could devise for them, perhaps we should not invest so much effort in arranging the exact format of instruction, but rather in other areas of need such as clarifying objectives and relations among objectives, improving the basic content elements of instruction and the means for evaluating progress, and motivating the learners.

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